

Magneto-Optical Surface Plasmon Resonance Biosensors with Uni-Axial Magnetic Anisotropy

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Surface plasmon resonance (SPR) is a surface-sensitive analytical technique used in a variety of biological sensors.¹ The main problem with classical SPR technology is associated with the existence of a lower physical limit of detection (LOD) with respect to fluorescence. Various approaches have been proposed to overcome this limitation by developing different sensing concepts including phase-sensitive detection schemes, use of metallic nanostructures, line gratings and others. More recently, the addition of active functionalities to the SPR based devices have been proposed to enhance the intrinsic sensitivity of the SPR system. A magneto-optical (MO) SPR sensor, based on a magneto-plasmonic modulation technique produced in multilayers of noble and ferromagnetic metals has been lately proposed.²

The use of trilayered thin film structure (e.g. Au/Ferro/Au) allow to provide a transverse magneto-optical Kerr effect (TMOKE) of p-polarized light. This TMOKE signal exhibit improved physical sensitivity over classic SPR measurements thanks to the non-reciprocal modification of the surface plasmon wave vector induced by the applied magnetic field.³ Moreover, this modulation of the surface plasmon wave vector in this kind of architecture allow application in active plasmonic as optical switches. Here we propose a novel combination of metals based on ferrimagnetic thin films composed of TbCo₂ stacked with FeCo providing a magnetic uniaxial anisotropy and giving rise to an easy and a hard magnetization axis in the structure.⁴ This specific structure add new behavior to exploit the active control of surface plasmon resonance.

Theoretical studies by using finite element analysis (comsol) are investigated thanks to the measure of the magneto-optical constant of the TbCo₂/FeCo multilayers by ellipsometry. The combination with experimental studies by coupling our architecture with a modified-SPR bench with external magnetic field controlled by Labview program, shows a significant increase of sensitivity when used in a magneto-plasmonic configuration. Moreover, the plasmonic properties came up with the magnetic characteristics allowing an indirect local measurement of the magnetic properties of the sample. The interest of this novel sensing device for the detection of cardiac biomarkers such as troponin I⁵ will be shown.

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